



Goddard Procedures and Guidelines

DIRECTIVE NO. GPG 1860.2
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Responsible Office: 250 / Safety and Environmental Division (S&E)

Title: Laser Radiation Protection

PREFACE

P.1 PURPOSE

This directive sets forth the Goddard Space Flight Center (GSFC) laser radiation protection program and contains administrative direction and guidance on organizational and procedural requirements. This directive also provides essential radiation protection information. Only laser radiation is addressed in this guide; other types of radiation are addressed in other documents.

P.2 APPLICABILITY

This directive is applicable to all GSFC personnel, facilities, and activities, including all permanent and temporary sites. This directive shall also apply to all GSFC tenant organizations, contractors, grantees, clubs and other persons operating on GSFC property as required by law and as directed by contractual, grant, and agreement documents.

P.3 AUTHORITY

- a. [NPD 8710.2](#), NASA Safety and Health Program Policy
- b. National Aeronautics and Space Act, 42 U.S.C. §§ 2451-2484

P.4 REFERENCES

- a. American National Standard for Safe Use of Lasers (ANSI Z136.1).
- b. American National Standard for Safe Use of Lasers Outdoors (ANSI Z136.6).
- c. American National Standard for Safe Use of Optical Fiber Communication Systems Utilizing Laser Diode and LED Sources (ANSI Z136.2).
- d. Federal Aviation Administration (FAA) Order 7400.2.
- e. [GPG 3410.2](#), Employee Competence and Quality Management System Training.
- f. [GSFC Form 23-6L](#), Request for Radiation Safety Committee (RSC) Action – Laser Radiation Source Personnel Approval.
- g. [GSFC Form 23-28L](#), Laser Radiation Source Questionnaire.
- h. [GSFC Form 23-35LU](#), Laser Radiation Source – Personnel Approval.

P.5 CANCELLATION

GHB 1860.3, Radiation Safety Handbook – Laser, May 30, 1978.

P.6 SAFETY

Section 1 addresses safe operating procedures.

P.7 TRAINING

Users and custodians must be appropriately trained in the safe use of lasers (see section 3, Table 3-1, and Table 3-2).

P.8 RECORDS

Documentation of training and certification is the responsibility of the appropriate management organization as set forth in GPG 3410.2.

Record Title	Record Custodian	Retention
Supervisory inspection of Class 1, 2, and 3a lasers	Office of Primary Responsibility	* <u>NRRS 8/38A</u> . Retire to Federal Records Center when 6 years old. Destroy when 75 years old.
GSFC Form 23-6L (Approved)	Office of Primary Responsibility	* <u>NRRS 8/38A</u>
GSFC Form 23-35LU (Approved)	Office of Primary Responsibility	* <u>NRRS 8/38A</u>
GSFC Form 23-28L		* <u>NRRS 8/38A</u>

*[NPG 1441.1](#) – NASA Records Retention Schedules (NRRS)

P.9 METRICS

Metrics will include the number of harmful employee exposures and the number of laser incidents, and will be reported quarterly to the RSC.

P.10 DEFINITIONS

a. Aviation protection requirements – Requirements that shall be applied to all outdoor laser systems that have a nominal ocular hazard distance greater than 250 feet or have levels in the visible spectrum in excess of those permitted in Laser Free/High Intensity Light/Flight Zone (LF/HIL/FZ) as defined in FAA Order 7400.2E, Part 6, Miscellaneous Procedures, Chapter 28, Outdoor Laser Operations.

- b. Outdoor laser operations – All uses of lasers in operations that involve the laser illumination of any area that is not enclosed by a physical structure. Outdoor laser operations include fixed ground-based systems, mobile ground-based systems, lasers fired through structure openings into outdoor areas, and flight systems (aircraft, balloons, and rocket payloads).
- c. Laser Free/High Intensity Light/Flight Zone (LF/HIL/FZ) – Effective 50 nW/cm²; indistinguishable from background ambient light.
- d. Critical Zone Exposure (CZE) – 5 microW/cm²; will not produce significant visual impairment.
- e. Sensitive Zone Exposure (SZE) – 100 microW/cm²; will begin to produce afterimage or flash-blindness effects.

PROCEDURES

1. ROLES AND RESPONSIBILITIES

Safe Operating Procedures

Safe operating procedures – A local-level Procedures and Guidelines or similar document describing safeguards for laser use must be written by the laser custodian, the laser safety officer (LSO), or other designated person, and reviewed and approved by GSFC's RSC Greenbelt, or the Wallops Flight Facility Safety Office, Wallops. Written safeguards must be posted on or near the laser control panel or at the entrance to the laser controlled area.

Class 1 and Class 2 systems as defined in ANSI Z136.1 are excluded from this requirement.

- a. Custodian – A user who has been designated by the appropriate management (section head or higher) and approved by the RSC to assume the responsibility of accountability for sources of hazardous laser radiation. The custodian is responsible for ensuring the proper use and storage of all sources of laser radiation under his/her custodianship.
- b. Employees – Any employee involved in radiological activities is responsible for knowing and following GSFC radiological safety requirements, environmental statutes, and operations-specific policies and procedures. They must use appropriate personal protective equipment when required and be familiar with the specific hazards associated with each laser used. They must immediately report all unsafe conditions or operations to their supervisor, Facilities Operations Manager, and/or the Safety & Environmental (S&E) or the Wallops Safety Office.
- c. Goddard Safety Council (GSC) – The GSC is responsible to the Director, GSFC, for overseeing development, direction, and implementation of GSFC's Health and Safety Program, including radiation protection.

d. LSO – The LSO will:

- (1) Provide for the inspection of laser radiation use and storage areas;
- (2) Audit laser source records and evaluate use programs to assure compliance with RSC requirements;
- (3) Maintain appropriate records of inspections and evaluations;
- (4) Act on behalf of the RSC as necessary. All actions will be reported to the RSC at the next meeting;
- (5) Require the immediate cessation of operations for any laser activities determined to pose an imminent threat to personnel safety; and
- (6) Provide consultation on Class 3b and Class 4 laser operations as requested.

e. Management – GSFC line management has primary responsibility for the physical safety of personnel working under their jurisdiction and for designating users and custodians of sources of laser radiation. The line manager must assure that laser sources are used only by individuals approved by GSFC's RSC and that all procedures and requirements are met. The line manager must ensure that hazard warning signs required by this directive are procured and posted by the user organization under the guidance of the LSO.

f. RSC – The RSC is responsible to the GSC for overseeing development, direction, and implementation of GSFC's Radiation Protection Program. The RSC will evaluate requests for committee action and, if satisfied that safe use will be made of the sources, will approve users, custodians, and uses of laser radiation sources. Approvals may be provided subject to certain requirements or restrictions imposed by the Committee. The Committee reserves the right to suspend all approvals if the requirements of GSFC's Radiation Protection Program and requirements of approval are not complied with. The Committee may designate a person or persons to give approval for routine requests. The RSC chairman may act on behalf of the RSC as necessary. All actions will be reported to the RSC at the next meeting. The RSC consists of representatives from various directorates with varying areas of expertise. The RSC will:

- (1) Be chaired by an individual designated by the Chief, S&E;
- (2) Meet at least quarterly, and as often as necessary to accomplish its responsibilities;
- (3) Ensure that laser radiation used at GSFC or under GSFC programs is managed so as to minimize the health and safety risks to government and contractor employees and the public;
- (4) Ensure that GSFC and other Federal regulations, professional standards, and sound health physics practices are met;
- (5) Approve laser operations and, if necessary, prescribe conditions and requirements to minimize radiation hazards;
- (6) Approve the qualifications of personnel as responsible users and custodians; and
- (7) Approve users of laser radiation producing devices.

g. S&E – The S&E staff has responsibility for laser radiation protection at GSFC (excluding Wallops). S&E will designate GSFC's Greenbelt LSO.

- h. Supervisors – Supervisors are responsible for employees and projects. They shall ensure that all facilities and equipment are properly maintained and that employees, where appropriate, are trained and knowledgeable in the proper use of lasers.
- i. User – A person designated by management who is approved by the RSC to use Class 3b or Class 4 sources of laser radiation or approved by management for Class 1, 2, and 3a lasers.
- j. Wallops Safety Office – Will designate a Wallops LSO who will provide review and preliminary approval of laser radiation activities at or managed by Wallops. The Wallops LSO will provide a list of preliminary approvals that have been granted at the quarterly RSC meetings. The Wallops Safety Office shall keep the records for Wallops laser safety, shall provide for the inspection of laser radiation use and storage areas, audit laser source records, and evaluate use programs to assure compliance with RSC requirements relating to laser radiation at that facility. Wallops will provide all outside coordination for Wallops projects.

2. LASER RADIATION OPERATIONS APPROVAL REQUIREMENTS

This section defines the process and requirements for obtaining RSC approval of users, custodians, devices, and operators involved with laser radiation sources. Approval procedures and methods are established to assure that work with sources of laser radiation is performed with due regard for radiological safety.

- a. Classification of Lasers – All lasers must be classified by the custodian/user and shall be determined according to their greatest normally accessible level of radiation and in accordance with the ANSI Z136.1 (latest edition), i.e., Class 1, 2, 3a, 3b, or 4.
- b. Laboratory Operations – Requests for approval for laboratory operations must be received by LSO at least 2 weeks prior to the work date for adequate processing. Complicated systems, procedures, flight projects, or extremely hazardous operations will take longer to acquire final approval. These systems should be coordinated with the LSO in the early planning stages to assure that there is no impact to mission schedule. For outdoor laser operations refer to section 6 and for offsite activities refer to section 8.
- c. Laser Radiation Source Approval – Class 3b or Class 4 lasers must be approved by the RSC. Committee approval is obtained by submitting a GSFC Form 23-6L. This form requires that the custodian/user include an operational safety plan or procedure. Approvals expire after 3 years.

NOTE: Class 3b laser pointers are not permitted for use at GSFC or its supported facilities.

- d. Laser Radiation Source Personnel Approval – Users and custodians of all Class 3b and Class 4 lasers must have approval of the RSC. Committee approval is obtained by submitting a GSFC Form 23-35LU. Approvals expire after 3 years. A baseline eye examination is required prior to approval (reference section 4). Upon approval, the LSO will issue a certification card that must be kept in the user's

possession at all times while using Class 3b or Class 4 laser systems. Applications for custodians must certify that the applicant has adequate education, training, and experience for the responsibilities of a custodian.

- e. User Certification – Users of Class 1, 2, and 3a lasers must obtain certification from the line management responsible for the operations. RSC approval is not required. Laser pointing devices displaying a Danger label may be capable of causing eye injury to the user or persons in the audience. The user must be careful when handling these devices.
- f. Procurement, Manufacture, Alterations, or New Installations of Laser Radiation Sources – When any Class 3b or Class 4 lasers or laser radiation sources are to be procured, manufactured, altered or a new laser installed, a GSFC Form 23-28L shall be submitted to S&E or the Wallops Safety Office. This form should also be used for assistance in the determination of laser classifications.
- g. Contractor and Guest Professional Operations – Contractors and other personnel operating at GSFC facilities are subject to all provisions of the GSFC Laser Safety Program. Contractors operating at contractor-operated facilities but in conjunction with GSFC programs will be required to develop a plan to address the hazards of working with laser radiation sources in accordance with ANZI Z136.1 and ANZI A136.6.

3. TRAINING REQUIREMENTS

Users and custodians must be appropriately trained in the safe use of lasers (see Tables 3-1 and 3-2). The following are course objectives:

- a. Course A –
 - (1) Have a basic understanding of laser principles and hazards; and
 - (2) Understand manufacturers' warnings, hazards, and use instructions.
- b. Course B – Accomplish Course A objectives, plus:
 - (1) Read and understand GPG 1860.2;
 - (2) Understand basic laser principles;
 - (3) Know user responsibilities and basic GSFC laser use approval procedures;
 - (4) Understand principles and properties of laser light;
 - (5) Understand laser exposure bio-effects;
 - (6) Recognize hazards;
 - (7) Understand hazard controls for laser radiation;
 - (8) Understand exposure control methods (engineering vs. administrative);
 - (9) Understand the RSC-imposed requirements;
 - (10) Know basic procedures and methods of handling laser approvals;
 - (11) Know responsibilities of users and custodians;
 - (12) Know the inspection and survey requirements; and
 - (13) Understand consequences of violations.

c. Course C – Accomplish Course B objectives, plus:

- (1) Understand advanced laser radiation mathematics;
- (2) Know beam characteristics and measurements;
- (3) Know hazard zone determinations; and
- (4) Understand laser protective eyewear selection.

d. Outdoor Laser Operations – Accomplish Course C objectives, plus:

- (1) Gain in-depth knowledge of laser safety, including non-damaging visual effects, emission calculations, and engineering controls required for their safe operation; and
- (2) Understand specific operating procedures and safety requirements of the laser installation.

Table 3-1
Laser User Training and Experience Requirements

Laser Class	Course	Experience*	Approval Authority
1	-	None	Management
2	A	Hands-On Instruction	Management
3a	A	Hands-On Instruction	Management
3b	B	1 Week operational	RSC
4	B	1 Month operational	RSC

* Other requirements may be substituted for experience as determined appropriate by the RSC.

Table 3-2
Laser Custodian Training and Experience Requirements

Laser Class	Course	Experience*	Approval Authority
3b	C	1 Week	RSC
4	C	1 Month	RSC
Outdoor Laser Operations	C+**	6 Months	RSC

* Other requirements may be substituted for experience as determined appropriate by the RSC.

** Training requirements are specified in Section 3.d.

4. BASELINE (PRE-PLACEMENT) AND TERMINATION EYE EXAMINATIONS

All approved users of Class 3b and Class 4 lasers are required to have a baseline eye exam approved by their employer(s). Additional exams shall be administered after any suspected exposure and are recommended upon termination of work with lasers. A baseline or termination eye exam shall consist of:

- a. Ocular history
- b. Visual acuity test
- c. Central visual fields test
- d. Contrast sensitivity test

If results of any of the above tests are abnormal, a more in-depth evaluation may be required if determined necessary by the medical provider.

5. INSPECTION REQUIREMENTS

- a. The line management responsible for laser operations shall inspect class 1, 2, and 3a lasers and installations using these lasers. Lasers and laser operations should be inspected periodically to check alterations that have taken place and verify that personnel operating the laser are appropriately trained. This requirement also includes areas or operations where laser pointers are used. Inspections should be documented and retained for LSO audit.
- b. All Class 3b and Class 4 laser installations shall be reviewed by the LSO prior to startup of operations and after each approved alteration. Class 3b and Class 4 installations shall be subject to periodic surveys and evaluations.

6. OUTDOOR LASER OPERATIONS

- a. All protective systems determinations shall be supported by qualitative and quantitative safety/hazard analysis. Proposed protective systems shall be submitted to the RSC for approval. All supporting documentation must be included.
- b. Laser systems directed towards outer space (which might disrupt orbiting satellites) shall have an approval from the Laser ClearingHouse, Space Defense Operations Center (SPADOC) on file with the RSC. See ANZI Z136.6 for information on which outdoor laser systems require approval from the Laser ClearingHouse. Information sheets for submission to the Laser ClearingHouse are available from the LSO.
- c. Federal Aviation Administration (FAA) coordination is required for all operations that will transmit laser energy through navigable air space controlled by the FAA. Coordination with the FAA shall be accomplished through the S&E.
- d. Special Requirements: No laser system having a Letter of Objection from the FAA shall operate.

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e. Evaluations of outdoor laser operations are the responsibility of the user organization. The LSO will make every effort to assist in providing technical guidance and review.

7. OPTICAL FIBER COMMUNICATION SYSTEMS USING LASER DIODES OR LED SOURCES

Users of fiber optics communications systems shall follow guidance provided in ANSI Z136.2. Since these systems may contain Class 3b or Class 4 lasers, use of open-ended optical fibers and LEDs must be approved by the RSC as described in section 2.c.

8. OFFSITE LASER OPERATIONS

Offsite operations will also be subject to the requirements and regulations of the use site. There has been an extensive proliferation of “local” rules, regulations, and laws throughout the United States and the world in response to public concern over ionizing and non-ionizing radiation. Approval of offsite operations may take an extended time. Offsite laser operations will require the appointment of a site laser safety officer for the project. This individual must have the authority and the insight to ensure that safe operations are conducted and local regulations met.

9. LASER RADIATION PROTECTION REQUIREMENTS

a. Requirements for control of hazards presented by lasers are located in section 4 of ANSI Z136.1, and are incorporated by reference. The application of control measures for the individual laser classes is shown in Table 10. Alternate control measures may be approved by the RSC. Adequate justification must accompany the RSC request for approval.

b. Protective eyewear will be relied upon only after all engineering efforts to eliminate the hazard have been attempted. Eye protection for laser hazards shall be reviewed and approved by the LSO. ANSI Z136.1 shall be consulted when identifying and selecting laser eye protective equipment.

c. Control of Associated Hazards (Non-Beam Hazard) – This aspect of laser technology is seldom encountered outside of the research and engineering laboratory and is associated with high power lasers almost exclusively. Non-beam hazards may include electrical, laser generated air contaminants, collateral and plasma radiation, fire, explosions, compressed gas, laser dyes, mechanical, noise, hazardous wastes, confined space, and ergonomics hazards. When these hazards are present, other requirements not addressed by this GPG are likely to apply. ANSI Z136.1 provides requirements and guidance related to these hazards.

10. CAUTION SIGNS, SYMBOLS, LABELS, AND POSTING

a. Except as otherwise authorized by the LSO, signs, symbols, and labels shall use the design and colors described in ANSI Z136.1.

- b. In addition to the contents of signs, symbols, and labels prescribed by this section, a user may provide on or near such signs, symbols, and labels any additional information that may be appropriate in aiding individuals to minimize exposure to laser radiation or any associated hazards.
- c. Laser warning signs and labels shall be posted as required and in accordance with ANSI Z136.1.
- d. Standard operating procedures for Class 3b and Class 4 lasers approved by the RSC and submitted with GSFC Form 23-6L must be posted on or near the laser control panel or at the entrance to the laser facility.

DIRECTIVE NO. GPG 1860.2
EFFECTIVE DATE: June 29, 2004
EXPIRATION DATE: June 29, 2009

Page 11 of 11

CHANGE HISTORY LOG

Revision	Effective Date	Description of Changes
Baseline	06/29/04	Initial Release